A WATER QUALITY ASSESSMENT OF KENOGAMISIS LAKE

AUGUST, 1982

Ministry of the Environment
Ontario

A WATER QUALITY ASSESSMENT
OF
KENOGAMISIS LAKE
DISTRICT OF THUNDER BAY

MUNICIPAL AND PRIVATE ABATEMENT SECTION
ONTARIO MINISTRY OF THE ENVIRONMENT
NORTHWESTERN REGION

July, 1982

MOE
KEN
WAT
ATHK

athk

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

LIST OF APPENDICES

SUMMARY

The Ontario Ministry of the Environment conducted a water quality survey of Kenogamisis Lake, District of Thunder Bay, during the first six months of 1981. This followed a preliminary investigation of potential arsenic and cyanide contamination, conducted during the summers of 1979 and 1980.

Samples of lake water and domestic drinking water supplies, were collected and analysed to determine if there was any water quality impairment as a result of previous mining activity, and the resultant deposition of tailings in and adjacent to the lake.

Iron and manganese levels were found to exceed Ministry drinking water objectives (0.3 and 0.05 mg/ℓ respectively), in the waters adjacent to the tailings deposits. Those waters found to contain elevated metal levels are not being utilized as drinking water supplies.

Sampled drinking waters, taken from the lake, all contained traces of arsenic; however, none exceeded the Ministry's drinking water rejection criterion of 0.05 mg/ℓ As.

Data collected over the past three years suggest that the arsenic concentration in Kenogamisis Lake has decreased. This, however, may not be the result of a long-term stable reduction, but rather due to overall climatic and hydrogeologic factors.

Cyanide was not detected in the waters of Kenogamisis Lake.

INTRODUCTION

Gold mining activities in the Geraldton area have, over a period of 30 years, resulted in the accumulation of extensive tailings deposits (finely milled ore wastes) in and adjacent to the waters of Kenogamisis Lake. The Ontario Ministry of the Environment (M.O.E.) monitored Kenogamisis Lake in 1979, in response to expressed concerns over potential impairment of the water quality.

Contaminants of particular concern are arsenic, which occurs naturally as arsenopyrite in the gold ore and cyanides which were used as chemical agents in the ore refining process.

In an effort to determine the levels of arsenic and cyanide in Kenogamisis Lake and neighbouring waters, the Ministry of the Environment conducted preliminary investigations in 1979 and 1980, followed by a comprehensive survey in 1981.

DESCRIPTION OF THE STUDY AREA

Kenogamisis Lake (86° 55', 49° 42'), located immediately south and east of the town of Geraldton, is relatively shallow, with a mean depth of 2.0 m (metres), a maximum depth of 9.8 m and a surface area of 2,543 ha (hectares). The major source of incoming water is the Kenogamisis River, which empties into the southwest arm of the lake. Several minor streams also drain into the southern portion of the lake. Drainage is primarily into the north arm, entering a continuation of the Kenogamisis River.

There are 36 permanent residences, 44 seasonal residences, 8 commercial establishments and a Provincial park, which currently draw drinking water either directly from the lake or from wells adjacent to the lake.

The lake is extensively used for recreational activity and provides a moderate sport fishery for walleye and northern pike.

METHODS

Eleven water quality stations were established on Kenogamisis Lake, only five of which were sampled during the winter months.

Data recorded in this report were generated from seven visits to the study area during the first six months of 1981. Additional samples were collected in November, 1981, and submitted

for arsenic speciation. Arsenic and cyanide levels, determined from one summer collection during 1979 and one summer collection during 1980, are also reported.

On-site measurements were made of temperature, dissolved oxygen and water transparency, the last measurement included during the summer sampling only. Dissolved oxygen and temperature readings were obtained with a YSI model 54 oxygen/temperature meter. Water transparency was measured with a 20 cm (centimetre) Secchi disc.

Water samples obtained during the ice-free period were collected from one metre below the surface with a modified Kemerer water sampler. Winter water samples were obtained from immediately beneath the ice.

With the exception of mercury, samples for heavy metal analyses were placed in one-litre plastic containers and preserved with one mℓ (millilitre) of nitric acid (HNO_3). Analyses for mercury were conducted on water samples collected in 150-mℓ glass bottles and preserved with 0.25 ml HNO_3 and 3 mℓ of potassium permanganate ($KMNO_4$). Cyanide samples were collected in one litre plastic containers and preserved with 2 mℓ of sodium hydroxide (NaOH). Samples for the measurement of the remaining chemical parameters were collected in one-litre glass containers with no preservatives added. Filtered arsenic concentrations were determined from preservative-free waters passed through a 1.2 μ (micron) Millipore filter. With the exception of the first set of arsenic samples, all remaining collections were filtered in the field. Bacterial counts were obtained from water samples collected in 150 mℓ, pre-sterilized glass bottles.

Drinking water samples for the measurement of arsenic and other water quality parameters, were collected from four locations adjacent to Kenogamisis Lake. Two sampling locations had a well water supply and two obtained waters direct from the lake. Samples were also collected from the Ressor Lake Water Treatment Plant, which provides domestic water for the town of Geraldton. Samples were collected twice per month, during the first six-month period of 1981.

Arsenic, in the chemical form of arsenite and cyanide concentrations were measured by the Ministry of the Environment Central Laboratory in Toronto. All other analyses were conducted at the Ministry's Regional Laboratory in Thunder Bay.

On June 1, sediment samples were collected at all of the 11 water sampling locations with a manual coring device. Samples were frozen for storage and later sectioned and submitted to the Ministry of the Environment Laboratory, Toronto, for metals analyses.

RESULTS AND DISCUSSIONS

WATER

Arsenic levels and sampling dates for 11 sample locations (Figure 1) on Kenogamisis Lake are presented in Tables 1 and 2.

The distribution of tailings and mean arsenic concentrations in the waters are illustrated in Figure 3. The highest levels were found in Barton Bay (represented by sites 2 through 5), adjacent to the largest and most recent tailings deposit. The area utilized for tailings deposition prior to the mine closure showed the highest off-shore concentration of arsenic (site 4, 0.38 mg/ℓ (milligrams per litre), 1979). The lowest concentrations were found in waters upstream of the tailings deposits (southwest arm). The in situ dissolution of arsenopyrite from native formations would appear to be responsible for the arsenic concentrations found in this section of the lake.

Results of the survey conducted during 1979 revealed that all sampling locations on Kenogamisis Lake had arsenic concentrations in excess of the Ministry's desirable drinking water objective (0.01 mg/ℓ); however, most sites were below the Ministry's rejection limit (0.05 mg/ℓ) (1-pp. 52). The average arsenic concentration for all sites was 0.091 mg/ℓ. Although elevated arsenic levels were again measured in 1980, all sample locations,

with the exception of site 8, exhibited a decrease when compared to the 1979 levels. The 1980 average arsenic concentration, 0.053 mg/ℓ, was approximately one-half the level found in 1979. A similar decrease was observed in 1981, with an average arsenic concentration of 0.027 mg/ℓ. Although the expressed average arsenic concentration is artificially elevated by the disproportionate representation of the lake, sampling stations were consistent from year to year and the average provides a number that one can use for comparison. The 1981 survey saw only one remaining sample location with a mean arsenic concentration which exceeded the Ministry's rejection criteria (site 5).

One can interpret these results in different ways: the arsenic concentration in Kenogamisis Lake is indeed rapidly decreasing with time; dissimilar weather conditions prevailed at the times of sampling; long-term climatic and hydrogeologic factors; a combination of the above.

Field filtration of the 1981 samples was designed to remove the arsenic adsorbed on the larger suspended particles and leave the soluble and finely-divided suspended fractions. The mean filtered and non-filtered arsenic concentrations were 0.020 and 0.027 mg/ℓ respectively. If a standard deviation of $\pm$.002 mg/ℓ is applied to allow for precision of analysis, little difference exists between the two measurements. It would appear that the measured arsenic during 1981 was largely in solution.

Recorded arsenic levels for 1979 and 1980 represent total arsenic and no distinction was made between the soluble and suspended fractions. Considering that the tailings were deposited directly in the water and on the shore, and that the lake is relatively shallow, adverse weather conditions could conceivably have increased the suspended arsenic fraction, thereby creating the discrepancies observed between 1979 and 1981. A review of the weather patterns, however, prior to and during the surveys (Table 3), does not support this theory. Owing to the very limited sampling done during 1979 and 1980, caution must be placed on these year to year comparisons.

With the exception of cyanide, no other water quality parameters were measured during the 1979 and 1980 surveys which would allow for comparison of other ion concentrations.

The 1981 study, which extended over a six-month period, provided an opportunity to examine seasonal fluctuations. Low arsenic levels as those recorded at Stations 1, 9 and 10, provided no apparent pattern. A seasonal trend was demonstrated in Barton Bay (Stations 3 and 4); however, with average arsenic concentrations for January 7, February 3, March 9, March 30, May 5, June 1 and June 30 of 0.028, 0.040, 0.038, 0.028, 0.014, 0.040 and 0.070 mg/ℓ respectively. The lowest concentration (0.014 mg/ℓ, May 5) coincided with the spring freshet. Including this springtime low, the average arsenic concentrations for the open water period (0.041 mg/ℓ) was higher than that recorded for the winter months (0.034 mg/ℓ). The function of temperature versus solubility may account for a small portion of this difference, however, the sediment resuspension which occurs during open water is presumed to be largely responsible.

Samples collected in November, 1981, and submitted to Toronto for arsenic speciation, revealed that arsenite (As^{+3}), the most toxic form, was less than 0.001 mg/ℓ at all sampling locations.

Samples of domestic water supplies, collected from four locations around the lake (Figure 2), revealed elevated arsenic levels. McLeod Townsite, which in the past obtained its drinking water from the southeast arm, had an average arsenic concentration of 0.008 mg/ℓ. The higher arsenic levels found in the northeast arm resulted in a level of .009 mg/ℓ being recorded for the Ministry of Natural Resources air base. Both communal systems met the Ministry's drinking water objective.

Domestic water for McLeod Townsite is now being provided by the Town of Geraldton. The mean arsenic concentration for Ressor Lake ($\bar{x}$ 0.003 mg/ℓ) was found to be well within the Ministry's objective for drinking water quality.

With respect to arsenic concentrations, the two well waters sampled represented two extremes. Average arsenic concentrations in unfiltered waters from Kenogamisis Lake Resort and the Ministry of Transportation and Communications (MTC) garage were 0.003 and 0.76 mg/ℓ respectively. Ministry of Transportation and Communications staff report that well waters from the MTC garage are not being used as a drinking water supply.

For general information, results of the remaining physical and chemical parameters measured for in the drinking waters have been appended (Appendices 1-3).

No cyanide values are available for water samples collected in 1979. Cyanide concentrations less than 0.001 mg/ℓ were found in all waters sampled in 1980 and again in 1981.

Physical and chemical data for the remaining parameters measured during 1981 are presented in Tables 4 through 10 and discussed below.

Analyses conducted for the remaining heavy metals revealed elevated levels of iron and manganese. Iron and manganese levels exceeded the Ministry of the Environment objectives for drinking water quality on several occasions at sites 3 and 4. A manganese concentration marginally in excess of the recommended criterion was also recorded at site 9 on May 5. Iron and manganese levels as those recorded in Kenogamisis Lake, do not present a potential health problem to the consumer, but on occasion exceeded a limit imposed for aesthetic purposes. None of the remaining heavy metals exceeded the Ministry's objective for drinking water quality.

Unlike most Precambrian Shield lakes, Kenogamisis is a moderately hard water lake ($\bar{x}$ 91.0 mg/ℓ) with a correspondingly high alkalinity ($\bar{x}$ 81.0 mg/ℓ). Hardness ranged from a winter high of 125.0 mg/ℓ to a springtime low of 53.0 mg/ℓ. This is consistent with the observed decline in calcium and magnesium levels. Similar observations were made in a small arctic lake by Schindler, et al. (1974). Springtime ion decline was attributed,

in part, to a phenomenon termed "freeze-out." Ions in solution have been shown to be forced from the freezing water to the underlying liquid, thereby concentrating those ions in a smaller volume of water. In light of this, ion concentrations measured in the waters immediately beneath the ice in Kenogamisis Lake may, in fact, be artificially elevated and creating a discrepancy between winter and spring values. Although ion concentration by freeze-out has been shown to occur, dilution from the spring meltwater is probably largely responsible for the observed decline.

Chloride and bicarbonate (HCO_3) demonstrated seasonal cycles similar to those of the major cations. Bicarbonate levels, reflected in the alkalinity measurements, dropped substantially in May to 70.4 mg/ℓ. This was a drop of 23 mg/ℓ from the 93.6 mg/ℓ recorded in April. Again, this substantial alteration is largely the result of meltwater dilution and the generally acidic nature of this runoff.

Although seasonal as well as station to station variability was observed, the excellent buffering capacity of Kenogamisis Lake served to maintain a neutral to slightly alkaline pH (7.0-8.5).

Conductivity determinations, a further measure of the ionic content of the water, are consistent with the observed seasonal trends. Combined conductivity measurements for the ice-covered and ice-free periods were 204 and 160 μmhos/cm respectively.

Turbidity, a measure of water clarity, relates to the amount of suspended particulate matter in the water column. Turbidity ranged from 0.30 to 7.8 (Formazin Units), with the highest levels recorded during the ice-free period. Water sampled from most locations during the ice-free period exceeded the Ministry's drinking water objective of 1.0 Formazin Units. Although particulate in the water can interfere with adequate disinfection, the limit of 1.0 Formazin Units has been selected to ensure consumer acceptability of the water supply rather than for health reasons.

Colour in water is derived from substances in solution and from materials in a colloidal state. Highest colour readings were obtained from waters collected at sites 3 and 4 (maximum 124 Hazen Units). The observed high colour measurements coincide with the elevated iron and manganese levels found at these sites. The Ministry's objective for drinking water (5.0 Hazen Units) was never realized. Again, one must distinguish between palatable and potable water supplies. The hazards associated with waters exceeding the colour criterion (5.0 Hazen Units), are dependent on the materials that are in solution. For the most part, however, these are natural detrital materials and they do not present a health problem.

An examination of nutrient levels indicates that Kenogamisis Lake has the potential to be relatively productive. Combined total phosphorus levels reached a springtime high of 0.043 mg/ℓ, well into the eutrophic range (Total P. >.029 mg/ℓ) as described by Vollenweider (1968). Nitrogen compounds (free ammonia, Kjeldahl nitrogen, nitrite, nitrate) followed natural seasonal trends, reaching peaks during winter stagnation and gradually decreasing during the ensuing summer months. Utilization of the nutrient compounds by phytoplankton and macrophytes is responsible for these declines. Highest nutrient levels in the lake were recorded at station 5, downstream of the Geraldton sewage treatment plant outfall. This influence remains detectable downstream on the lake, to sample location 4.

Chlorophyll a measurements followed natural seasonal trends, with average chlorophyll a measurements for May 5, June 1 and June 30 of 1.7, 2.5 and 6.4 μg/ℓ respectively.

The coliform group of micro-organisms has been the most commonly used bacteriological indicator of water quality. Winter sampling on Kenogamisis Lake revealed total and fecal coliform counts of <4 colonies/100 mℓ at all sampling locations with the exception of site 4. Water collected from site 4, reached a maximum total coliform count of 40 col/100 mℓ during this period. The Geraldton Sewage Treatment Plant is in all likelihood responsible for the marginal increase. An additional site (site 5)

included during the summer sampling period was the lake site most strongly influenced by the sewage treatment plant outfall. Waters collected from site 5, produced the highest total coliform count, reaching 2,200 col/100 mℓ on June 30. This was the only site which exceeded the Ministry's objective for total body contact (T.C. <1000 col/100 mℓ). Only marginal increases in total coliform counts were found in the remaining areas of the lake, with no increase in fecal coliform levels observed.

All surface waters taken for domestic purposes should be chlorinated prior to consumption. Chlorine should be introduced to the water at a level which would provide adequate disinfection. In terms of bacteria, all waters of Kenogamisis Lake, if disinfected, would be safe for consumption.

SEDIMENT

Results of sediment analyses are illustrated in Table 15.

Although all the measured elements occur naturally in the sediment, there existed large variations in measured concentrations from different areas of the lake. Concentration ranges for arsenic, zinc, nickel, lead, iron and aluminum were 1200-2.0, 300-12, 76-1.6, 55-<30, 64,000-2,600 and 22,000-1,500 µg/g respectively. The highest concentration of each of the above elements was found in Barton Bay (sites 2, 3 and 4), adjacent to the large onshore deposit of mine tailings. Relatively high concentrations were also found at Station 6, adjacent to a second tailings area.

The "soupy" nature of the sediment near the tailings areas further shows that the tailings deposited on or near the shore have washed in, covering the natural substrate (compacted sand) in the lake.

The highest concentration of manganese (1,400 µg/g) was found at Station 9, in addition to an unexpectedly high concentration of other elements. Station 9 is located in a relatively open area, immediately north of the east narrows (Figure 2).

Accelerated water movement through the narrows and the subsequent slow movement at Station 9 could result in the settling of suspended particulate in this area.

Highest concentrations of all elements were found in the top 4 cm of the sediment with substantial decreases in the 5-8 cm depth range.

Microbial methylation or reduction can solubilize sedimented metal compounds and allow them to re-enter the water column (Ferguson, 1972). Based on the above, arsenic and other metal concentrations in the water (particularly in areas where tailings cover the natural substrate) could continue to be elevated for many years to come.

CONCLUSIONS

Test results revealed that arsenic was present in all waters of Kenogamisis Lake. Lowest concentrations (background levels) were found near the major incoming feeder stream and the highest levels were found adjacent to the most recent tailings deposit. High arsenic concentrations found in the waters adjacent to the tailings sites would indicate these to be the major source of contamination.

Arsenic concentrations in domestic waters marginally exceeded the Ministry's drinking water objective on a few occasions, however, average concentrations for the six-month period were below the recommended objective of 0.01 mg/ℓ.

In examining the data collected over the past three years, it would appear that the arsenic concentration in Kenogamisis Lake is decreasing with time. However, the recorded annual decreases are substantial and repeated extensive surveys are required to demonstrate, with reasonable certainty, any year to year trends. As there has been no recent addition of tailings to this area, arsenic will flush from the system with time. In addition, chemical reactions, such as microbial methylation, will

provide some loss to the system. However, even with the loss, one would think that the reintroduction of arsenic to the water column from the contaminated substrate would provide a more "steady state" than that which has been observed. The observed decreases in the arsenic concentration may not be the result of any long term stable conditions, but may in fact be due to overall climatic and hydrogeologic factors.

Results of the most recent survey indicate that Kenogamisis Lake, with the exception of Barton Bay, currently provides a drinking water supply that is in compliance with Ministry of the Environment objectives. Arsenic, iron and manganese levels exceeded the Ministry's objectives for drinking water in some areas of Barton Bay, demonstrating the current unsuitability of this area as a drinking water supply.

Cyanide does not presently appear to be a contaminant of any concern in the waters of Kenogamisis Lake.

RECOMMENDATIONS

1. Any public water supply currently being taken from Kenogamisis Lake or adjacent wells should be on a regular arsenic testing program.
2. Waters from Barton Bay should not be used as a drinking water supply, without adequate treatment.
3. Should any expanded uses be considered for Barton Bay, an extensive survey should be repeated at some point to establish if, in fact, the arsenic concentration is decreasing and if so, to what degree.

REFERENCES

1. Ferguson, J. F. and J. Gavis. 1972. A review of the arsenic cycle in natural waters. Wat. Res., 6:1259-1274.

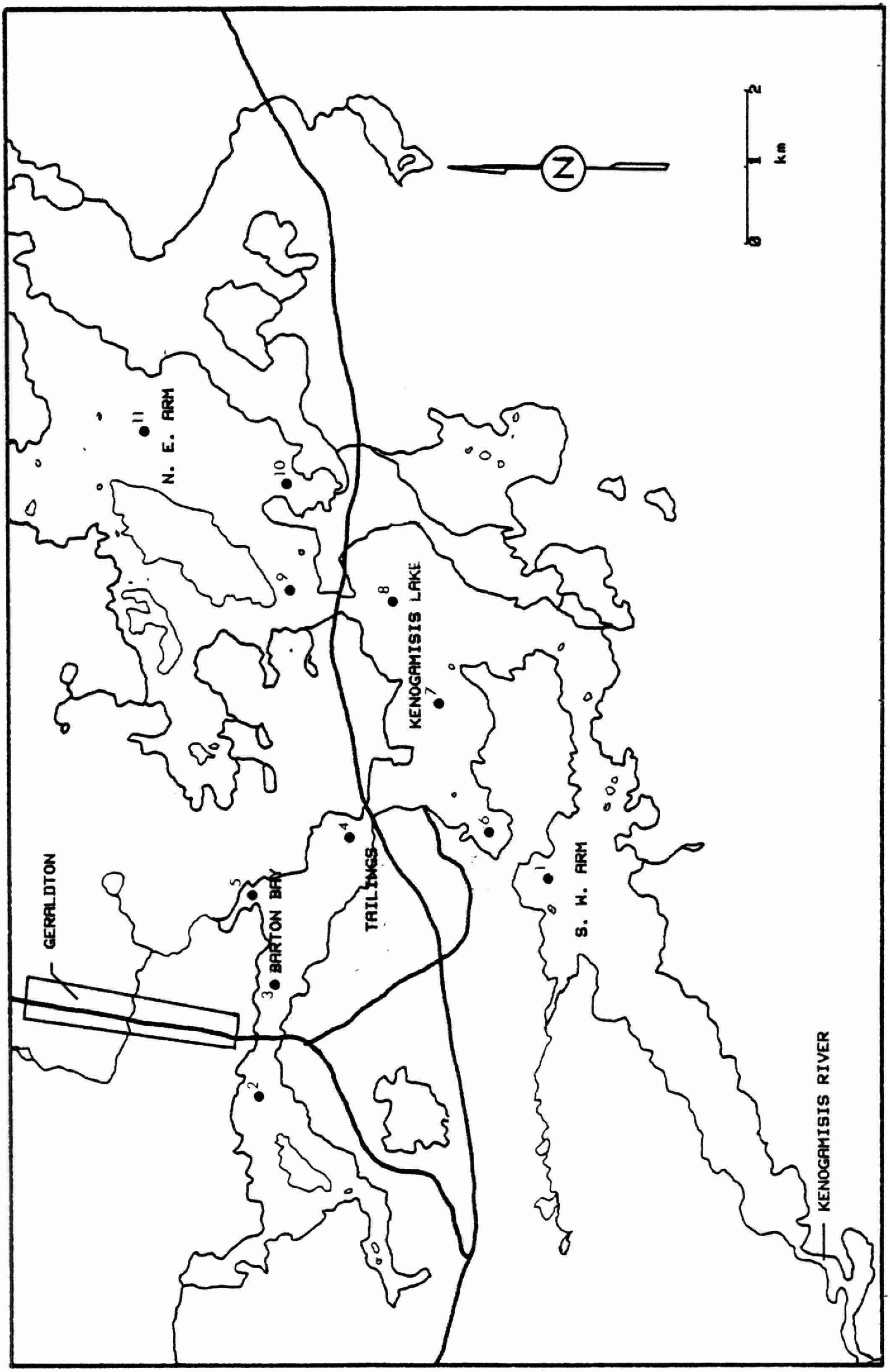
2. Ontario Ministry of the Environment. 1968. Water management: goals, policies, objectives and implementation procedures of the Ministry of the Environment. O.M.O.E. pub.

3. Ontario Ministry of the Environment. 1979. Rationale for the establishment of Ontario's provincial water quality objectives. O.M.O.E. pub.

4. Schindler, D. W., H. E. Welch, J. Kalff, A. J. Brunskill, and N. Kritsch. 1974. Physical and chemical limnology of Char Lake, Cornwallis Island (75° N. Lat.). J. Fish Res. Bd. Can., 31:585-607.

5. Vollenwider, R. A. 1968. The scientific basis of lake and stream eutrophication, with particular reference to phosphorus and nitrogen as eutrophication factors. Organ. Econ. Coop. Dev. Paris (DAS/CSI/68), Tech. Rep. 2P:1-182.

FIGURE 1 KENOGAMISIS LAKE - WATER SAMPLE SITES



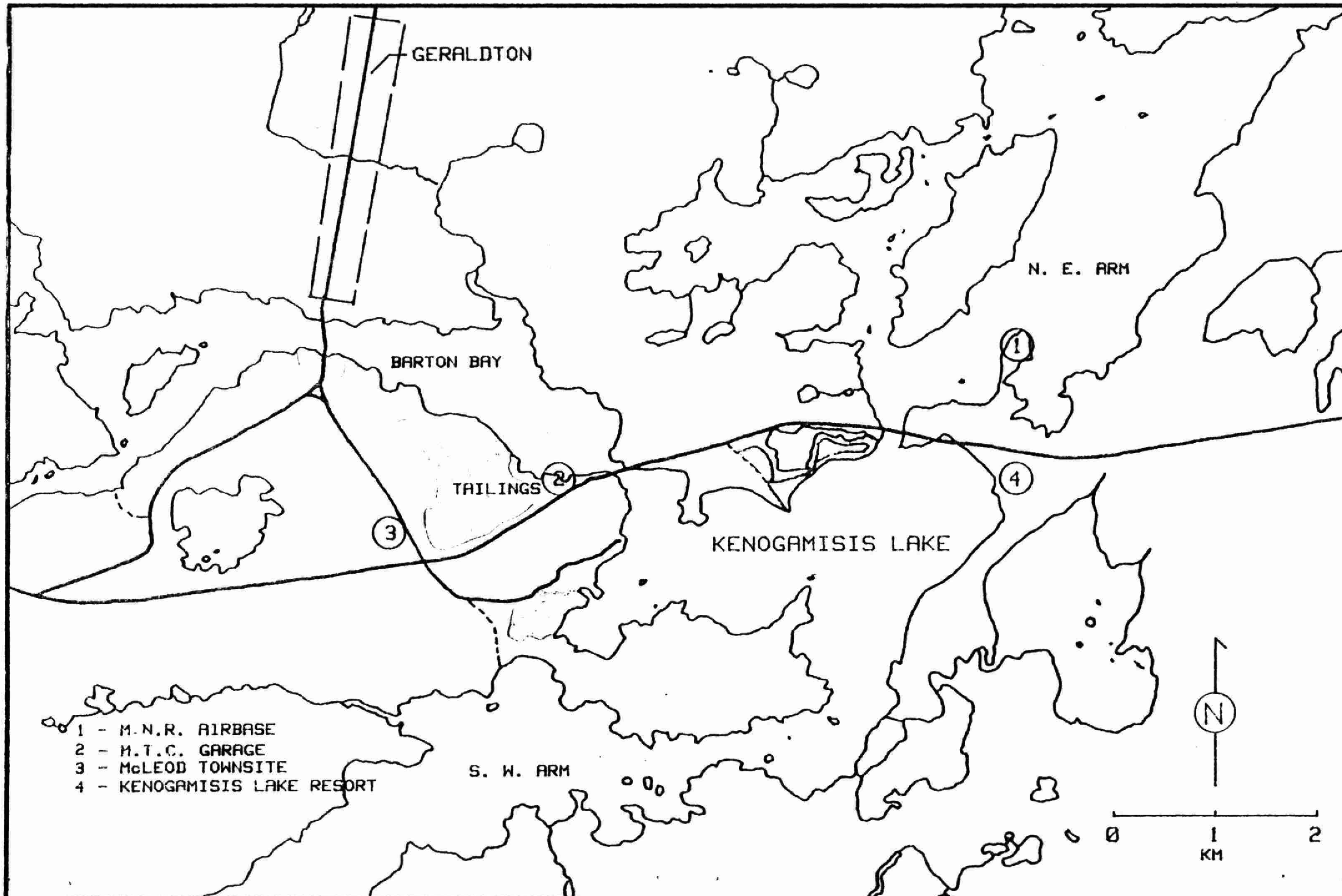


FIGURE 2 KENOGAMISIS LAKE DOMESTIC WATER SAMPLE SITES

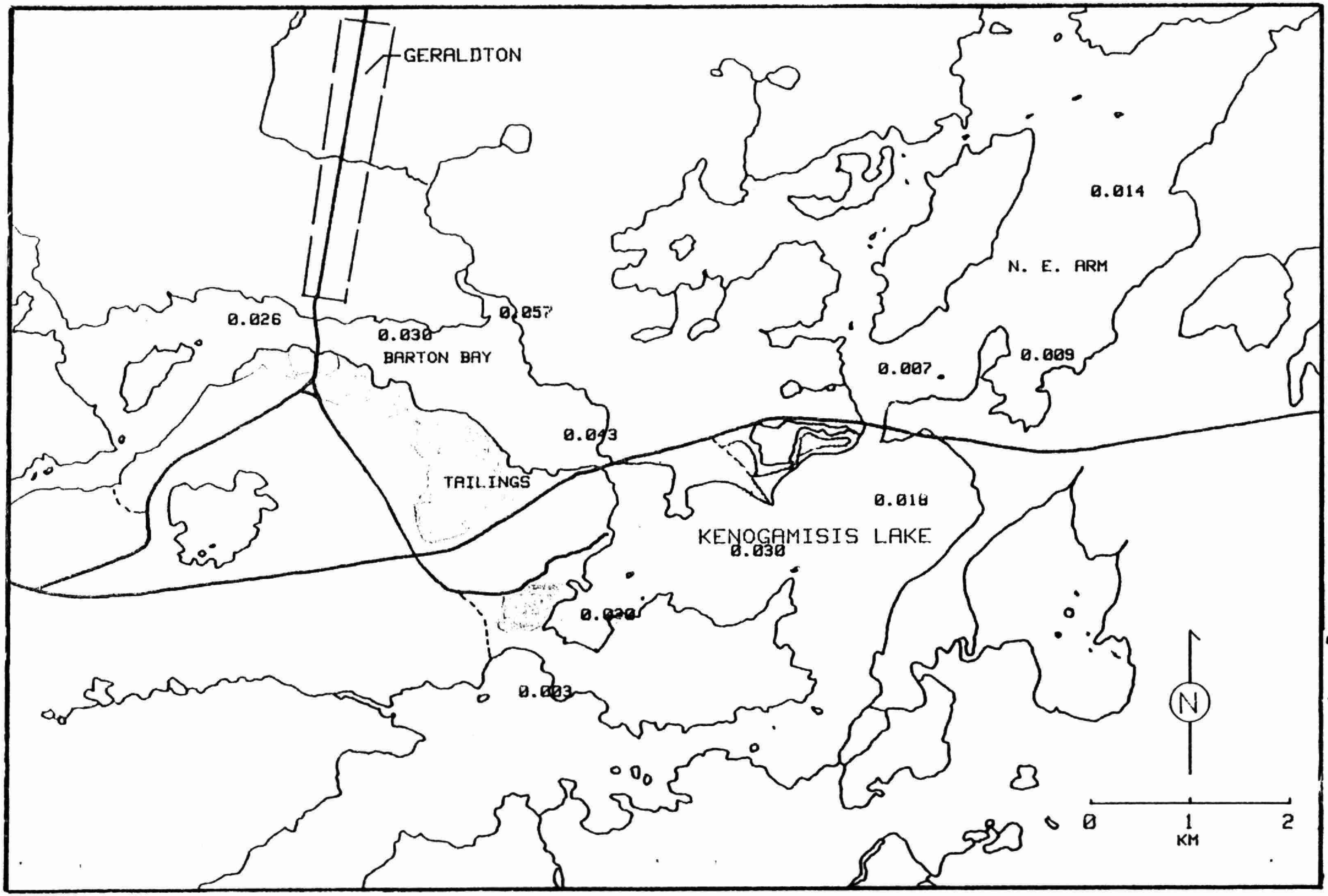


FIGURE 3 KENOGAMISIS LAKE
MEAN ARSENIC CONCENTRATION (mg/l), 1981.

TABLE 1. Arsenic concentrations from 11 sample locations on Kenogamisis Lake, 1979-81.

Sample Location	Arsenic as As (mg/ℓ) 1979	1980	1981 Mean Total
1	0.015	0.006	.003
2	0.150	0.070	.026
3	0.170	0.110	.030
4	0.380	0.140	.043
5	--	--	.057
6	0.046	0.041	.030
7	0.043	0.030	.030
8	0.026	0.078	.022
9	0.027	0.018	.007
10	0.028	0.018	.009
11	0.029	0.018	.014

TABLE 2. Arsenic concentrations (total and filtered) from 11 sample locations on Kenogamisis Lake, 1981.

Sample Location	Arsenic Measured	Date						
		Jan 7	Feb 3	Mar 9	Mar 30	May 5	Jun 1	Jun 30
1	Total	.003	<.001	<.001	.002	.007	.005	<.004
	Filtered	.002	<.001	.001	.002	.006	.006	<.004
2	Total	--	--	--	--	--	.026	.025
	Filtered	--	--	--	--	--	.019	.022
3	Total	.023	.038	.032	.021	.012	.033	.052
	Filtered	.025	.042	.028	.016	.009	.018	.047
4	Total	.032	.042	.044	.034	.016	.046	.087
	Filtered	.031	.050	.045	.032	.017	.036	.079
5	Total	--	--	--	--	--	.030	.084
	Filtered	--	--	--	--	--	.013	.067
6	Total	--	--	--	--	--	.030	.029
	Filtered	--	--	--	--	--	.020	.027
7	Total	--	--	--	--	--	.031	.029
	Filtered	--	--	--	--	--	.020	.028
8	Total	--	--	--	--	--	.018	.025
	Filtered	--	--	--	--	--	.010	.012
9	Total	.005	.007	.002	.005	.006	.015	.012
	Filtered	.005	.007	.005	.004	.007	.007	.012
10	Total	.011	.003	.007	.009	.006	.015	.012
	Filtered	.011	.006	.008	.008	.008	.007	.010
11	Total	--	--	--	--	--	.015	.012
	Filtered	--	--	--	--	--	.007	.012

NOTE: Arsenic concentrations reported in mg/ℓ

TABLE 3. Climatological data for the Geraldton area during the weeks: August 15-21, 1979, July 9-15, 1980, May 26-June 1 and June 24-30, 1981.

Date	Rainfall (mm)	Snowfall water equiv. (mm)	Total precipitation (mm)	Average wind direction and speed
Aug 15, 1979	0	0	0	3006[1]
16	0	0	0	2310
17	TR	0	TR	2308
18	0.4	0	0.4	2807
19	TR	0	TR	2606
20	TR	0	TR	0606
21	0	0	0	2405
Jul 9, 1980	16.0	0	16.0	2610
10	0	0	0	2811
11	0	0	0	0906
12	TR	0	TR	2109
13	0	0	0	2710
14	0.4	0	0.4	2306
May 26, 1981	0	0	0	0907
27	0	0	0	2705
28	0	0	0	2408
29	3.6	0	3.6	2312
30	TR[2]	0.6	0.6	3308
31	0	0	0	2710
Jun 1	0	0	0	2307
Jun 24, 1981	0.6	0	0.6	1006
25	0	0	0	0408
26	0	0	0	2206
27	0	0	0	2210
28	11.2	0	11.2	2006
29	23.8	0	23.8	0206
30	0	0	0	2004

[1]Where wind from 30^0 at 06 knots.
North = 0^0, East = 9^0, South = 18^0, and West = 27^0.

[2]TR = Trace

TABLE 4. Concentration of selected physical, chemical and microbiological parameters in waters collected from five sites on Kenogamisis Lake, January 7, 1981.

Parameters	Site 1	Site 2	Site 3	Site 4	Site 5	Site 6	Site 7	Site 8	Site 9	Site 10	Site 11
Cyanide	--	--	--	--	--	--	--	--	--	--	--
Zinc	--	--	--	--	--	--	--	--	--	--	--
Copper	--	--	--	--	--	--	--	--	--	--	--
Lead	--	--	--	--	--	--	--	--	--	--	--
Nickel	--	--	--	--	--	--	--	--	--	--	--
Iron	.15	--	.25	.20	--	--	--	--	.15	.15	--
Cobalt	--	--	--	--	--	--	--	--	--	--	--
Cadmium	--	--	--	--	--	--	--	--	--	--	--
Manganese	--	--	--	--	--	--	--	--	--	--	--
Aluminum	--	--	--	--	--	--	--	--	--	--	--
Mercury	--	--	--	--	--	--	--	--	--	--	--
Calcium	32	--	30	32	--	--	--	--	28	27	--
Potassium	1.1	--	.55	1.1	--	--	--	--	.91	.93	--
Sodium	.97	--	2.0	2.8	--	--	--	--	.99	1.2	--
Magnesium	6	--	1	7	--	--	--	--	6	6	--
Hardness	107	--	81	109	--	--	--	--	93	91	--
Alkalinity	101	--	86	94	--	--	--	--	86	85	--
pH (lab)	7.5	--	7.1	7.2	--	--	--	--	7.4	7.4	--
Conductivity (μmhos/cm)	210	--	195	220	--	--	--	--	185	185	--
Colour (Hazen Units)	53	--	124	95	--	--	--	--	53	61	--
Turbidity (Formazin Units)	.30	--	.45	.35	--	--	--	--	.40	.45	--
Acidity	5	--	12	7	--	--	--	--	5	6	--
Chloride	0.8	--	2.9	4.4	--	--	--	--	0.9	1.4	--
Sulphate	1.3	--	5.0	3.5	--	--	--	--	1.3	2.0	--
Temperature (^{0}C)	0.0	--	0.0	0.0	--	--	--	--	0.0	0.0	--
Dissolved Oxygen	--	--	--	--	--	--	--	--	--	--	--
Secchi disc transparency	--	--	--	--	--	--	--	--	--	--	--

TABLE 4. (Continued).

Parameters	Site 1	Site 2	Site 3	Site 4	Site 5	Site 6	Site 7	Site 8	Site 9	Site 10	Site 11
Phenols	--	--	--	--	--	--	--	--	--	--	--
Free Ammonia	.03	--	.06	.06	--	--	--	--	.03	.03	--
Total Kejldahl	.61	--	1.0	.91	--	--	--	--	.85	.93	--
Nitrite	.004	--	.009	.008	--	--	--	--	.004	<.001	--
Nitrate	.03	--	.05	.08	--	--	--	--	.04	.04	--
Total Phosphorus	.019	--	.030	.040	--	--	--	--	.013	.023	--
Diss. Rea. Phosphorus	.001	--	.013	.026	--	--	--	--	.004	.008	--
Chlorophyll a (μg/ℓ)	--	--	--	--	--	--	--	--	--	--	--
Total Coliform (col/100 m/ℓ)	<4	--	<4	40	--	--	--	--	<4	<4	--
Background Colonies (col/100 m/ℓ)	4	--	<4	44	--	--	--	--	4	<4	--
Fecal Coliform (col/100 m/ℓ)	<4	--	<4	<4	--	--	--	--	<4	<4	--
Fecal Streptococci (col/100 m/ℓ)	<4	--	<4	<4	--	--	--	--	<4	<4	--

All analyses reported in mg/ℓ unless otherwise indicated.

TABLE 5. Concentration of selected physical, chemical and microbiological parameters in waters collected from five sites on Kenogamisis Lake, February 3, 1981.

Parameters	Site 1	Site 2	Site 3	Site 4	Site 5	Site 6	Site 7	Site 8	Site 9	Site 10	Site 11
Cyanide	--	--	--	--	--	--	--	--	--	--	--
Zinc	--	--	--	--	--	--	--	--	--	--	--
Copper	--	--	--	--	--	--	--	--	--	--	--
Lead	--	--	--	--	--	--	--	--	--	--	--
Nickel	--	--	--	--	--	--	--	--	--	--	--
Iron	.10	--	.80	.30	--	--	--	--	.15	.10	--
Cobalt	--	--	--	--	--	--	--	--	--	--	--
Cadmium	--	--	--	--	--	--	--	--	--	--	--
Manganese	--	--	--	--	--	--	--	--	--	--	--
Aluminum	--	--	--	--	--	--	--	--	--	--	--
Mercury	--	--	--	--	--	--	--	--	--	--	--
Calcium	34	--	34	35	--	--	--	--	30	29	--
Potassium	.89	--	.48	.66	--	--	--	--	.76	.76	--
Sodium	.65	--	2.3	4.0	--	--	--	--	.78	.88	--
Magnesium	7	--	7	6	--	--	--	--	5	6	--
Hardness	115	--	113	113	--	--	--	--	97	97	--
Alkalinity	110	--	103	97	--	--	--	--	94	90	--
pH (lab)	7.6	--	7.0	7.1	--	--	--	--	7.3	7.5	--
Conductivity (μmhos/cm)	220	--	225	240	--	--	--	--	195	190	--
Colour (Hazen Units)	55	--	106	110	--	--	--	--	58	61	--
Turbidity (Formazin Units)	.30	--	1.1	.55	--	--	--	--	.30	.25	--
Acidity	7	--	17	17	--	--	--	--	8	7	--
Chloride	.70	--	3.9	6.6	--	--	--	--	.80	1.0	--
Sulphate	2.6	--	5.1	6.9	--	--	--	--	3.2	3.1	--
Temperature (^{o}C)	0.0	--	0.0	0.0	--	--	--	--	0.0	0.0	--
Dissolved Oxygen	--	--	--	--	--	--	--	--	--	--	--
Secchi disc transparency	--	--	--	--	--	--	--	--	--	--	--

TABLE 5. (Continued).

Parameters	Site 1	Site 2	Site 3	Site 4	Site 5	Site 6	Site 7	Site 8	Site 9	Site 10	Site 11
Phenols	--	--	--	--	--	--	--	--	--	--	--
Free Ammonia	.01	--	.04	.02	--	--	--	--	<.01	.01	--
Total Kejldahl	.42	--	.62	.65	--	--	--	--	.39	.32	--
Nitrite	.002	--	.008	.006	--	--	--	--	.002	.002	--
Nitrate	.08	--	.20	.33	--	--	--	--	.09	.08	--
Total Phosphorus	.011	--	.047	.065	--	--	--	--	.012	.013	--
Diss. Rea. Phosphorus	.004	--	.024	.055	--	--	--	--	.005	.006	--
Chlorophyll a (μg/ℓ)	--	--	--	--	--	--	--	--	--	--	--
Total Coliform (col/100 mℓ)	<4	--	<4	<4	--	--	--	--	<4	<4	--
Background Colonies (col/100 mℓ)	<4	--	4	4	--	--	--	--	<4	<4	--
Fecal Coliform (col/100 mℓ)	<4	--	<4	<4	--	--	--	--	<4	<4	--
Fecal Streptococci (col/100 mℓ)	<4	--	<4	<4	--	--	--	--	<4	<4	--

All analyses reported in mg/ℓ unless otherwise indicated.

TABLE 6. Concentration of selected physical, chemical and microbiological parameters in waters collected from five sites on Kenogamisis Lake, March 9, 1981.

Parameters	Site 1	Site 2	Site 3	Site 4	Site 5	Site 6	Site 7	Site 8	Site 9	Site 10	Site 11
Cyanide	--	--	--	--	--	--	--	--	--	--	--
Zinc	.004	--	.015	.014	--	--	--	--	.001	.009	--
Copper	.001	--	.002	.003	--	--	--	--	<.001	<.001	--
Lead	.029	--	.039	.017	--	--	--	--	.066	.018	--
Nickel	<.001	--	.002	.002	--	--	--	--	<.001	<.001	--
Iron	.10	--	.50	2.6	--	--	--	--	.15	.15	--
Cobalt	.001	--	.001	.001	--	--	--	--	.001	<.001	--
Cadmium	.001	--	.001	.001	--	--	--	--	.001	.002	--
Manganese	.005	--	.110*	.026	--	--	--	--	.007	.006	--
Aluminum	<.001	--	.027	.011	--	--	--	--	<.001	.017	--
Mercury	--	--	--	--	--	--	--	--	--	--	--
Calcium	34	--	37	35	--	--	--	--	32	31	--
Potassium	1.2	--	.50	.98	--	--	--	--	.90	.84	--
Sodium	1.8	--	2.4	3.8	--	--	--	--	1.1	1.2	--
Magnesium	6	--	8	6	--	--	--	--	6	5	--
Hardness	109	--	125	113	--	--	--	--	107	99	--
Alkalinity	103	--	97	96	--	--	--	--	103	92	--
pH (lab)	7.7	--	7.1	7.2	--	--	--	--	7.6	7.5	--
Conductivity (μmhos/cm)	205	--	215	220	--	--	--	--	200	185	--
Colour (Hazen Units)	46	--	106	106	--	--	--	--	49	57	--
Turbidity (Formazin Units)	.30	--	.80	2.0	--	--	--	--	.35	.30	--
Acidity	6	--	23	17	--	--	--	--	8	7	--
Chloride	1.8	--	3.3	5.8	--	--	--	--	.80	1.0	--
Sulphate	2.1	--	5.0	6.0	--	--	--	--	2.0	2.4	--
Temperature (^{0}C)	0.0	--	2.5	2.5	--	--	--	--	--	1.0	--
Dissolved Oxygen	9.6	--	4.2	2.8	--	--	--	--	--	7.8	--
Secchi disc transparency	--	--	--	--	--	--	--	--	--	--	--

TABLE 6. (Continued).

Parameters	Site 1	Site 2	Site 3	Site 4	Site 5	Site 6	Site 7	Site 8	Site 9	Site 10	Site 11
Phenols	--	--	--	--	--	--	--	--	--	--	--
Free Ammonia	.01	--	.04	.03	--	--	--	--	<.01	<.01	--
Total Kejldahl	.55	--	.65	.86	--	--	--	--	.34	.41	--
Nitrite	.003	--	.005	.006	--	--	--	--	.002	.002	--
Nitrate	.15	--	.18	.39	--	--	--	--	.13	.10	--
Total Phosphorus	.012	--	.022	.045	--	--	--	--	.011	.010	--
Diss. Rea. Phosphorus	<.001	--	.009	.024	--	--	--	--	.003	.005	--
Chlorophyll a (μg/ℓ)	--	--	--	--	--	--	--	--	--	--	--
Total Coliform (col/100 mℓ)	<4	--	<4	<4	--	--	--	--	<4	<4	--
Background Colonies (col/100 mℓ)	8	--	8	36	--	--	--	--	12	4	--
Fecal Coliform (col/100 mℓ)	<4	--	<4	<4	--	--	--	--	<4	<4	--
Fecal Streptococci (col/100 mℓ)	<4	--	<4	<4	--	--	--	--	<4	<4	--

*Result verified
All analyses reported in mg/ℓ unless otherwise indicated.

TABLE 7. Concentration of selected physical, chemical and microbiological parameters in waters collected from five sites on Kenogamisis Lake, March 30, 1981.

Parameters	Site 1	Site 2	Site 3	Site 4	Site 5	Site 6	Site 7	Site 8	Site 9	Site 10	Site 11
Cyanide	--	--	--	--	--	--	--	--	--	--	--
Zinc	.005	--	.027	.013	--	--	--	--	.006	.011	--
Copper	.005	--	.008	.012	--	--	--	--	.004	.011	--
Lead	.002	--	.006	.002	--	--	--	--	.001	.001	--
Nickel	<.001	--	.001	<.001	--	--	--	--	<.001	.001	--
Iron	.15	--	.30	.30	--	--	--	--	.20	.15	--
Cobalt	<.001	--	.001	.001	--	--	--	--	<.001	.002	--
Cadmium	.004	.001	--	.001	--	--	--	--	<.001	.004	--
Manganese	.007	--	.078	.078	--	--	--	--	.008	.008	--
Aluminum	.039	--	.044	.038	--	--	--	--	.038	.054	--
Mercury	<.05	--	<.05	<.05	--	--	--	--	<.05	<.05	--
Calcium	30	--	28	38	--	--	--	--	32	27	--
Potassium	1.2	--	.57	.94	--	--	--	--	.88	.96	--
Sodium	.93	--	2.1	5.0	--	--	--	--	.74	1.1	--
Magnesium	6	--	4	7	--	--	--	--	6	7	--
Hardness	100	--	88	125	--	--	--	--	104	98	--
Alkalinity	94	--	78	109	--	--	--	--	99	88	--
pH (lab)	7.5	--	7.0	7.0	--	--	--	--	7.4	7.4	--
Conductivity (μmhos/cm)	190	--	175	250	--	--	--	--	195	180	--
Colour (Hazen Units)	27	--	79	92	--	--	--	--	35	53	--
Turbidity (Formazin Units)	.45	--	.65	.55	--	--	--	--	.30	.65	--
Acidity	5	--	18	19	--	--	--	--	10	7	--
Chloride	0.9	--	4.1	7.5	--	--	--	--	0.9	1.4	--
Sulphate	3.0	--	5.8	8.8	--	--	--	--	3.5	3.9	--
Temperature (^{o}C)	2.0	--	2.0	1.5	--	--	--	--	1.5	1.0	--
Dissolved Oxygen	10.2	--	3.8	4.0	--	--	--	--	11.8	11.6	--
Secchi disc transparency	--	--	--	--	--	--	--	--	--	--	--

TABLE 7. (Continued).

Parameters	Site 1	Site 2	Site 3	Site 4	Site 5	Site 6	Site 7	Site 8	Site 9	Site 10	Site 11
Phenols	<1	--	<1	<1	--	--	--	--	<1	<1	--
Free Ammonia	.05	--	.15	.12	--	--	--	--	.02	.05	--
Total Kejldahl	.86	--	.83	.78	--	--	--	--	.44	.76	--
Nitrite	.004	--	.004	.011	--	--	--	--	.003	.004	--
Nitrate	.21	--	.19	.35	--	--	--	--	.14	.16	--
Total Phosphorus	.008	--	.022	.064	--	--	--	--	.008	.008	--
Diss. Rea. Phosphorus	.001	--	.003	.054	--	--	--	--	.004	<.001	--
Chlorophyll a (μg/ℓ)	--	--	--	--	--	--	--	--	--	--	--
Total Coliform (col/100 m/ℓ)	<4	--	12	52	--	--	--	--	<4	<4	--
Background Colonies (col/100 m/ℓ)	8	--	24	64	--	--	--	--	4	48	--
Fecal Coliform (col/100 m/ℓ)	<4	--	<4	<4	--	--	--	--	<4	<4	--
Fecal Streptococci (col/100 m/ℓ)	<4	--	<4	<4	--	--	--	--	<4	<4	--

All analyses reported in mg/ℓ unless otherwise indicated.

TABLE 8. Concentration of selected physical, chemical and microbiological parameters in waters collected from five sites on Kenogamisis Lake, May 5, 1981.

Parameters	Site 1	Site 2	Site 3	Site 4	Site 5	Site 6	Site 7	Site 8	Site 9	Site 10	Site 11
Cyanide	--	--	--	--	--	--	--	--	--	--	--
Zinc	<.001	--	<.001	<.001	--	--	--	--	.002	.029	--
Copper	.005	--	.002	.004	--	--	--	--	.003	.005	--
Lead	<.001	--	<.001	.004	--	--	--	--	.015	<.001	--
Nickel	<.001	--	<.001	.002	--	--	--	--	.003	.001	--
Iron	.12	--	.15	.18	--	--	--	--	.13	.41	--
Cobalt	<.001	--	<.001	<.001	--	--	--	--	<.001	<.001	--
Cadmium	<.001	--	<.001	<.001	--	--	--	--	<.001	.001	--
Manganese	.006	--	.007	.014	--	--	--	--	.058	.020	--
Aluminum	<.001	--	.020	.017	--	--	--	--	.008	.003	--
Mercury	--	--	--	--	--	--	--	--	--	--	--
Calcium	22	--	16	20	--	--	--	--	30	31	--
Potassium	.51	--	.27	.42	--	--	--	--	.71	.73	--
Sodium	.59	--	1.2	2.7	--	--	--	--	2.4	1.9	--
Magnesium	5	--	3	3	--	--	--	--	5	4	--
Hardness	75	--	53	63	--	--	--	--	98	96	--
Alkalinity	69	--	47	54	--	--	--	--	91	91	--
pH (lab)	7.4	--	7.4	7.5	--	--	--	--	7.2	7.4	--
Conductivity (μmhos/cm)	147	--	110	142	--	--	--	--	210	200	--
Colour (Hazen Units)	32	--	51	46	--	--	--	--	55	55	--
Turbidity (Formazin Units)	.50	--	.45	.50	--	--	--	--	.55	2.2	--
Acidity	6	--	6	4	--	--	--	--	10	7	--
Chloride	0.5	--	2.0	4.5	--	--	--	--	3.2	3.0	--
Sulphate	--	--	--	--	--	--	--	--	--	--	--
Temperature (^{o}C)	4.0	--	4.0	4.0	--	--	--	--	4.0	4.0	--
Dissolved Oxygen	10.1	--	9.6	11.2	--	--	--	--	11.2	--	--
Secchi disc transparency	--	--	--	--	--	--	--	--	--	--	--

TABLE 8. (Continued).

Parameters	Site 1	Site 2	Site 3	Site 4	Site 5	Site 6	Site 7	Site 8	Site 9	Site 10	Site 11
Phenols	--	--	--	--	--	--	--	--	--	--	--
Free Ammonia	.01	--	<.01	.05	--	--	--	--	.02	.05	--
Total Kejldahl	.22	--	.23	.30	--	--	--	--	.30	.36	--
Nitrite	.002	--	.003	.002	--	--	--	--	.002	.002	--
Nitrate	.03	--	.02	.01	--	--	--	--	.05	.04	--
Total Phosphorus	.009	--	.011	.029	--	--	--	--	.012	.015	--
Diss. Rea. Phosphorus	.004	--	.005	.016	--	--	--	--	.006	.003	--
Chlorophyll a (µg/ℓ)	1.4	--	.80	2.2	--	--	--	--	1.3	2.6	--
Total Coliform (col/100 mℓ)	--	--	8	20	--	--	--	--	<4	<4	--
Background Colonies (col/100 mℓ)	--	--	56	112	--	--	--	--	16	36	--
Fecal Coliform (col/100 mℓ)	--	--	<4	<4	--	--	--	--	<4	<4	--
Fecal Streptococci (col/100 mℓ)	--	--	<4	<4	--	--	--	--	<4	<4	--

All analyses reported in mg/ℓ unless otherwise indicated.

TABLE 9. Concentration of selected physical, chemical and microbiological parameters in waters collected from 11 sites on Kenogamisis Lake, June 1, 1981.

Parameters	Site 1	Site 2	Site 3	Site 4	Site 5	Site 6	Site 7	Site 8	Site 9	Site 10	Site 11
Cyanide	<.01	<.01	<.01	<.01	<.01	<.01	<.01	<.01	<.01	<.01	<.01
Zinc	.001	.003	.003	.004	.001	.002	.005	.003	.001	.003	.002
Copper	.007	.004	.001	.003	.004	.001	.006	<.001	.005	<.001	.001
Lead	.008	.002	.004	.006	.005	.005	.004	.007	.006	.002	.005
Nickel	<.001	.001	.001	.003	.003	.001	.001	.001	<.001	.002	<.001
Iron	.073	.190	.220	.320	.180	.200	.150	.110	.092	.088	.079
Cobalt	.001	.001	.002	<.001	.002	.001	.002	<.001	.001	<.001	.001
Cadmium	<.001	<.001	.001	<.001	<.001	.001	<.001	.001	.001	.001	<.001
Manganese	.008	.010	.010	.010	.011	.010	.009	.001	.010	.011	.010
Aluminum	.052	.035	.057	.091	.051	.032	.040	.034	.017	.020	.015
Mercury	<.05	<.05	<.05	<.05	<.05	<.05	<.05	<.05	<.05	<.05	<.05
Calcium	23	21	21	22	21	22	21	22	22	23	23
Potassium	.59	.27	.33	.48	.37	.55	.54	.54	.57	.55	.92
Sodium	.70	1.4	1.8	2.6	2.4	2.2	2.1	1.5	1.4	1.5	1.5
Magnesium	3	3	3	4	5	4	4	3	4	4	4
Hardness	70	66	66	72	72	72	71	69	71	73	73
Alkalinity	69	59	60	62	61	65	79	65	66	69	69
pH (lab)	7.8	7.8	7.7	7.8	7.5	7.8	7.8	7.8	7.5	7.5	7.6
Conductivity (μmhos/cm)	146	134	140	160	150	155	150	146	146	155	150
Colour (Hazen Units)	54	75	70	57	73	33	33	48	45	46	43
Turbidity (Formazin Units)	.75	1.7	1.8	2.3	1.4	1.5	1.4	.90	.90	.80	.75
Acidity	2	3	3	3	4	2	3	2	2	2	3
Chloride	0.4	1.7	2.6	4.6	4.2	2.9	3.0	1.8	1.5	1.7	1.6
Sulphate	2.8	2.2	2.6	4.7	2.7	5.1	4.8	3.2	3.5	4.4	3.9
Temperature (^{o}C)	13.5	14.0	14.0	13.5	15.0	13.0	13.0	13.5	13.5	12.5	12.5
Dissolved Oxygen	9.6	9.4	9.0	9.2	8.4	9.8	9.4	9.4	9.2	9.4	9.6
Secchi disc transparency	2.0	2.0	2.0	1.5	--	2.0	--	2.0	--	--	2.5

TABLE 9. (Continued).

Parameters	Site 1	Site 2	Site 3	Site 4	Site 5	Site 6	Site 7	Site 8	Site 9	Site 10	Site 11
Phenols	--	--	--	--	--	--	--	--	--	--	--
Free Ammonia	<.01	<.01	<.01	<.01	<.01	<.01	<.01	<.01	<.01	<.01	<.01
Total Kejldahl	.35	.44	.46	.45	.48	.37	.33	.34	.33	.34	.37
Nitrite	.003	.004	.003	.003	.004	.002	.002	.003	.003	.002	.002
Nitrate	<.01	<.01	<.01	<.01	.06	<.01	<.01	<.01	<.01	<.01	<.01
Total Phosphorus	.010	.013	.019	.040	.048	.016	.016	.014	.012	.013	.014
Diss. Rea. Phosphorus	.002	.011	.012	.019	.029	.012	.011	.006	.005	.004	.005
Chlorophyll a (μg/ℓ)	1.9	1.7	3.4	4.0	2.3	2.3	2.7	2.7	2.5	2.4	1.8
Total Coliform (col/100 mℓ)	4	16	32	64	C2200[1]	4	24	4	<4	4	<4
Background Colonies (col/100 mℓ)	36	148	136	128	4.0×10^4	36	100	36	144	124	96
Fecal Coliform (col/100 mℓ)	<4	<4	<4	<4	52	<4	<4	<4	<4	<4	<4
Fecal Streptococci (col/100 mℓ)	<4	<4	<4	<4	8	<4	<4	<4	<4	<4	<4

All analyses reported in mg/ℓ unless otherwise indicated.
[1]C = approximately

TABLE 10. Concentration of selected physical, chemical and microbiological parameters in waters collected from 11 sites on Kenogamisis Lake, June 30, 1981.

Parameters	Site 1	Site 2	Site 3	Site 4	Site 5	Site 6	Site 7	Site 8	Site 9	Site 10	Site 11
Cyanide	<.01	<.01	<.01	<.01	<.01	<.01	<.01	<.01	<.01	<.01	<.01
Zinc	.003	.003	.004	.002	.004	.003	<.006	.001	.001	.003	.002
Copper	<.001	<.001	.002	.004	.014	.001	.008	<.001	.002	.002	.006
Lead	.010	.009	.012	.013	.014	.013	.011	.010	.013	.014	.018
Nickel	<.001	<.001	<.001	<.001	<.001	<.001	.003	<.001	.001	.001	.002
Iron	.084	.164	.188	.189	.147	.182	.121	.180	.065	.081	.089
Cobalt	<.001	.001	.003	<.001	<.001	.001	<.001	.002	.002	<.001	.002
Cadmium	.001	.001	<.001	.001	.001	.001	.001	.001	.001	<.001	<.001
Manganese	.011	.010	.022	.018	.014	.012	.011	.011	.008	.011	.011
Aluminum	.035	.045	.050	.065	.055	.045	.045	.015	.005	.025	.020
Mercury	<.05	<.05	<.05	<.05	<.05	<.05	<.05	<.05	<.05	<.05	<.05
Calcium	23	22	22	23	24	22	23	23	23	22	23
Potassium	.62	.22	.34	.47	.53	.58	.65	.61	.60	.62	.62
Sodium	.78	1.4	1.9	2.7	3.2	1.9	1.6	1.0	1.2	1.2	1.2
Magnesium	3	3	4	4	5	4	3	3	3	4	3
Hardness	72	67	70	75	79	73	72	72	72	72	71
Alkalinity	74	61	64	66	69	66	66	68	68	67	68
pH (lab)	7.4	7.5	7.8	8.5	8.1	8.0	8.1	7.9	7.8	7.7	7.7
Conductivity (μmhos/cm)	170	153	163	175	185	170	170	165	165	168	170
Colour (Hazen Units)	51	83	83	80	81	55	56	54	54	44	45
Turbidity (Formazin Units)	.85	1.4	2.9	7.8	1.2	4.9	4.8	2.4	2.4	1.9	1.9
Acidity	3	3	2	0	1	1	1	3	2	2	3
Chloride	0.4	1.7	2.6	4.2	5.1	2.4	2.3	1.1	1.4	1.5	1.5
Sulphate	3.8	3.0	3.0	5.0	4.0	3.9	3.9	2.8	2.7	2.7	3.9
Temperature (^{0}C)	16.0	16.0	15.5	15.5	15.5	14.5	15.5	16.5	16.0	17.0	16.0
Dissolved Oxygen	9.0	8.8	9.0	9.4	9.0	9.5	9.0	9.4	9.2	8.8	9.8
Secchi disc transparency	2.0	2.0	1.5	1.0	1.0	1.5	1.5	2.2	2.3	2.0	2.3

TABLE 10. (Continued).

Parameters	Site 1	Site 2	Site 3	Site 4	Site 5	Site 6	Site 7	Site 8	Site 9	Site 10	Site 11
Phenols	--	--	--	--	--	--	--	--	--	--	--
Free Ammonia	.02	.02	.02	.02	.04	.01	.01	<.01	.02	.01	.01
Total Kejldahl	.37	.47	.58	.97	1.2	.65	.69	.48	.53	.43	.42
Nitrite	.004	.004	.004	.004	.007	.004	.003	.003	.003	.003	.003
Nitrate	.01	.01	.01	.01	.05	.01	.01	.01	.01	.01	.01
Total Phosphorus	.011	.013	.020	.035	.065	.021	.020	.013	.014	.013	.014
Diss. Rea. Phosphorus	.003	.013	.019	.030	.029	.016	.014	.006	.007	.006	.007
Chlorophyll a (μg/ℓ)	1.9	1.6	5.6	10	18	7.0	9.0	4.9	4.6	3.6	3.8
Total Coliform (col/100 mℓ)	4	120	C88	C160	C1600[1]	C8	C8	8	16	C40	C16
Background Colonies (col/100 mℓ)	72	440	1160	G10000[2]	80000	2000	2800	1080	1120	3200	3400
Fecal Coliform (col/100 mℓ)	<4	<4	<4	<4	N/A	4	<4	<4	<4	<4	<4
Fecal Streptococci (col/100 mℓ)	<4	<4	<4	<4	12	4	<4	<4	<4	<4	<4

All analyses reported in mg/ℓ unless otherwise indicated.
[1]C = approximately
[2]G = greater than

TABLE 11. Arsenic concentrations in waters collected adjacent to Kenogamisis Lake, February through July, 1981.

Date	Ressor L. Raw		Ressor L. Treated		M.T.C. Garage		McLeod Tw. Raw		McLeod Tw. Treated		M.N.R. Raw		M.N.R. Treated		Kenogamisis L. Resort	
	1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2
Feb 23	.003	.004	.002	.004	.77	.12	.008	.006	.006	.007	--	--	.008	.009	.003	.002
Mar 9	.001	<.001	<.001	<.001	.95	.15	--	--	.005	.004	--	--	.006	.006	<.001	<.001
Mar 23	.001	.001	<.001	.001	1.00	.060	.002	.001	.002	.002	--	--	.005	.005	--	--
Apr 6	.001	.001	.001	.001	.93	.065	.28*	.27*	.095*	.095*	--	--	.008	.006	--	--
Jun 1	.005	.004	.008	<.004	.045	.009	--	--	.011	.014	.013	.011	.011	.011	<.004	--
Jun 15	<.004	<.004	<.004	<.004	.97	.011	--	--	.014	.009	.015	.010	.011	.007	<.004	<.004
Jun 29	<.004	<.004	<.004	<.007	.62	.051	--	--	.007	.006	--	--	.010	.008	.004	<.004
Jul 14	<.004	<.004	<.004	<.004	.81	.057	.010	.008	.013	.010	--	--	.019	.014	<.004	<.004

NOTE: 1. Total arsenic (mg/ℓ).
2. Arsenic concentration following filtration (mg/ℓ).
Samples filtered through Whatman glass microfiber filter #934-AH.
Precision of analysis ±.002 mg/ℓ.
* Results questionable.

TABLE 12. Gradient concentrations of selected metal parameters in sediment samples collected from Kenogamisis Lake, June 3, 1981.

Site No.	Depth (cm)	Parameters											
		As	Zn	Cu	Ni	Pb	Cd	Fe	Au	Al	Co	Hg	Mn
1	0-2	23	17	3.3	4.3	4.5	<0.3	5700	<1	3000	2		110
2	0-2	270	260	240	54	55	<0.3	39000	<1	13000	17		680
2	2-4	270	300	140	55	42	<0.3	39000	<1	13000	16		690
2	4-6	200	180	93	37	16	0.65	23000	<1	9900	10		370
3	0-2	880	180	150	54	37	0.3	48000	<1	15000	19		630
3	2-4	740	180	170	57	38	<0.3	47000	<1	15000	18		530
3	4-6	620	190	170	52	41	<0.3	42000	<1	13000	18		710
4	0-2	1200	210	230	66	26	<0.3	63000	<1	22000	20		520
4	2-4	1200	200	260	76	25	0.35	64000	<1	21000	20		510
4	4-6	300	80	79	22	7.5	<0.3	20000	<1	8600	7		210
4	6-8	31	46	12	9	<3	<0.3	9400	<1	6100	4.3		140
5	0-2	140	210	150	6	43	0.8	11000	<2	5300	9		150
5	4-6	90	79	38	7.5	8	<0.6	6500	<2	3600	<4		130
5	6-8	30	57	23	6	5.5	<0.6	5800	<2	3400	<4		120
6	0-2	590	160	170	49	20	0.45	62000	<1	16000	22		650
6	2-4	380	150	160	51	17	0.40	59000	1.5	15000	21		570
6	4-6	750	110	120	28	10	0.35	53000	1.5	14000	8.8		680
7	0-2	250	170	240	46	31	0.3	39000	<2	15000	12		470
7	2-4	220	190	290	51	30	<0.3	38000	<2	15000	12		430
7	4-6	61	80	43	19	6.0	<0.3	25000	<2	12000	7.2		370
7	6-8	25	66	14	19	<6	<0.3	24000	<2	12000	6.4		380
8	0-2	5.5	12	5.3	1.6	<3	<0.3	4500	<1	1500	<2.5		48
8	2-4	2.0	12	3.1	6.3	<3	0.3	5900	<1	3600	<2.5		74
8	4-6	2.0	13	3.9	6.7	<3	<0.3	6800	<1	4400	2.7		97
8	6-8	2.0	15	4.4	7.7	<3	<0.3	6900	<1	4300	2.7		100

TABLE 12. (Continued).

Site No.	Depth (cm)	Parameters											
		As	Zn	Cu	Ni	Pb	Cd	Fe	Au	Al	Co	Hg	Mn
9	0-2	280	150	98	39	27	<0.3	40000	<2	17000	11		1400
9	2-4	80	100	40	24	10	0.52	31000	<1	16000	8.5		950
9	4-6	20	95	20	22	4.4	0.4	32000	<1	16000	8.6		960
9	6-8	12	97	20	23	4.8	0.4	33000	<1	17000	8.6		960
10	0-2	26	39	16	11	3.0	0.3	6000	<1	6000	3.8		190
11	0-2	49	31	10	7.0	3.1	<0.3	3600	<1	3600	3.0		290
11	2-4	12	14	3.6	5.4	<3.0	<0.3	2600	<1	2600	4.1		170

Note: All results reported in μg/g

APPENDIX 1. Concentration of selected physical and chemical parameters in waters collected adjacent to Kenogamisis Lake, January 12, 1981.

Parameters	Ressor L. Raw	Ressor L. Treated	M.T.C. Garage	McLeod Tw. Raw	McLeod Tw. Treated	M.N.R. Raw	M.N.R. Treated	Kenogamisis L. Resort
Hardness	152	152	1505	--	111	91	93	--
Alkalinity	144	135	270	--	102	82	85	--
Iron	.10	.05	24	--	1.4	.25	.10	--
Chloride	2.8	3.5	60	--	1.2	1.4	2.3	--
pH (pH Units)	7.6	7.3	7.1	--	7.5	8.0	7.5	--
Colour (Hazen Units)	17	8	281	--	51	37	51	--
Turbidity (Formazin Units)	.50	.25	120	--	.35	.55	.35	--
Conductivity	295	300	2600	--	215	185	190	--
Arsenic (Total)	.002	<.001	1.09	--	.005	.019	.011	--

All analyses reported in mg/ℓ unless otherwise indicated.

APPENDIX 2. Concentration of selected physical and chemical parameters in waters collected adjacent to Kenogamisis Lake, January 26, 1981.

Parameters	Ressor L. Raw	Ressor L. Treated	M.T.C. Garage	McLeod Tw. Raw	McLeod Tw. Treated	M.N.R. Raw	M.N.R. Treated	Kenogamisis L. Resort
Hardness	152	154	1525	--	111	--	95	323
Alkalinity	145	139	286	--	107	--	88	295
Iron	.10	.05	14.5	--	.15	--	.15	.25
Chloride	2.9	4.4	46	--	1.2	--	1.9	2.4
pH (pH Units)	7.5	7.4	7.0	--	7.4	--	7.4	7.2
Colour (Hazen Units)	20	9	235	--	49	--	54	16
Turbidity (Formazin Units)	.60	.25	99	--	.30	--	.30	.50
Conductivity	300	315	2600	--	215	--	190	590
Arsenic (Total)	.003	.001	.54	--	.004	--	.007	.002

All analyses reported in mg/ℓ unless otherwise indicated.

APPENDIX 3. Concentration of selected physical and chemical parameters in waters collected adjacent to Kenogamisis Lake, February 10, 1981.

Parameters	Ressor L. Raw	Ressor L. Treated	M.T.C. Garage	McLeod Tw. Raw	McLeod Tw. Treated	M.N.R. Raw	M.N.R. Treated	Kenogamisis L. Resort
Hardness	154	152	1535	117	113	--	95	291
Alkalinity	151	139	307	104	109	--	91	286
Iron	.10	<.05	16	.15	.15	--	.10	.40
Chloride	4.2	4.2	53	.9	1.0	--	2.1	2.2
pH (pH Units)	7.5	7.1	7.0	7.4	7.4	--	7.4	7.2
Colour (Hazen Units)	20	8	69	51	50	--	53	24
Turbidity (Formazin Units)	.45	.25	105	.55	.40	--	.30	.75
Conductivity	300	310	2600	225	225	--	195	560
Arsenic (Total)	<.001	<.001	.69	<.001	<.001	--	.006	<.001

All analyses reported in mg/ℓ unless otherwise indicated.

Date Due
